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Seasonal cattle preferences in a mountainous riparian zone: final report

Wayne Leininger and Andy Pelster

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"Seasonal Cattle Preference in a Mountainous Riparian Zone"
COLORADO STATE UNIVERSITY
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FINAL REPORT

SEASONAL CATTLE PREFERENCES IN A MOUNTAINOUS RIPARIAN ZONE

Agreement No. INT-95040-RJVA

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CHAPTER 1

Introduction

In the western United States, the greatest threat to the ecological integrity of riparian zones has been from grazing by domestic livestock (Kauffman and Krueger 1983, Marlow and Pogacnik 1985), while at the same time human recreational demands and wildlife use are significant in riparian areas (Armour et al. 1994). Because of the multiple-use value of riparian areas, many throughout the West have been altered to some degree. However, degraded riparian areas are generally restorable through improved management practices (Chaney et al. 1990).

Livestock can damage riparian areas by grazing (i.e., removing) protective vegetation and through trampling (Benke and Raleigh 1978, Marlow and Pogacnik 1985, Clary and Webster 1990). Clary (1995) reported that in Idaho, there was a reduction in growth and biomass production in sedge (*Carex* spp.) dominated communities following grazing. In addition, there was a consistent reduction of plant growth when compaction occurred annually. Sedgwick and Knopf (1991) found that after only 3 years, willows (*Salix* spp.) showed a

negative response to a moderate level of grazing. Excessive grazing and trampling can cause a reduction or elimination of riparian vegetation. The loss or reduction of riparian vegetation leads to changes in streambank morphology, widened stream channels and a subsequent lowering of the surrounding water table (Benke and Raleigh 1978). In contrast, adequate streamside vegetation traps sediment and facilitates the rebuilding and maintenance of streambanks (Clary and Webster 1990).

Numerous different grazing systems have been applied to riparian zones, but no single grazing system has been successful in every riparian situation (Platts and Nelon 1985, Clary and Booth 1993). Grazing systems that are effective in protecting ecological values control the season, frequency and intensity of grazing. Successful managers must know how the soils, vegetation, and animals will react to their management practices at different times during the grazing season (Marlow and Pogacnik 1985). Roath and Krueger (1982) stressed the need for detailed information on livestock distribution and the types and amounts of forage consumed within the riparian zone. These authors also noted that the mechanisms influencing each parameter must be known in order to effectively use the information.

Although every riparian area may respond differently to

grazing, some grazing strategies have been found to be effective. Bryant (1985) reported that in Oregon a deferred- or rest-rotation system gave the largest increase in herbage production of the various systems tested. The author also noted that season-long grazing and short-duration, high-intensity grazing systems showed the least improvement. In a review of 34 grazing systems, Meyers (1989) found that in Montana successful systems allowed vegetation regrowth or rest during at least 75% of the years. He also reported that successful systems averaged 28 days of grazing per treatment, while unsuccessful grazing systems averaged 59 days of use. Meyers recommended that fall grazing should be limited as much as practically possible where deciduous woody species are important.

Roath and Krueger (1982) found that cattle tended to concentrate in the riparian zone early in the grazing season. However, the authors stated that the livestock were released within the riparian area, which may have contributed to their results. On the other hand, Clary and Booth (1993) suggested that spring grazing is a good management strategy. The authors found that cattle were not noticeably attracted to the riparian zone during early-season grazing. They felt that high surface soil moisture acted as a deterrent, causing livestock to prefer the uplands. As illustrated above, the

response of riparian zones to grazing management is erratic and unpredictable.

Although there have been numerous studies that have addressed livestock distribution (Bryant 1982, Roath and Krueger 1982, Marlow and Pogacnik 1986, Pinchak et al. 1991, Clary and Booth 1993) and vegetation utilization (Kauffman et al. 1983, Platts and Nelson 1985, Smith et al. 1992) within the riparian zone, few studies have directly addressed cattle diet selection within these ecosystems (Holechek et al. 1982, Huber et al. 1995). It has not been quantified whether changes in diet selection by cattle in the riparian zone are caused by changes in relative palatabilities of herbaceous and woody plants or by changes in the availability of herbaceous vegetation as stubble heights decrease. However, Kauffman et al. (1983) observed that shrub use was related to availability of herbaceous forage. They felt that as long as herbaceous forage was available, shrub utilization would not occur with late-season grazing by cattle. Similarly, Meyers (1989) observed that utilization of deciduous woody species by cattle in a riparian zone in Montana increased in late-August and remained heavy through the fall. Similar observations were made by Kinch (1989) in Oregon. However, the latter two studies did not address the availability of herbaceous forage. More information on how and when livestock use important

riparian species is needed in order for managers to better control grazing in riparian areas (Marlow and Pogacnik 1986).

Few guidelines describing allowable use by livestock in riparian ecosystems are available to resource managers (Clary and Webster 1989). Stubble height recommendations appear to be applicable and easy to use for this purpose. Several authors have made stubble height recommendations developed to protect the ecological integrity of riparian ecosystems. The principal strategy is to maintain stubble heights at sufficient heights to sustain forage plant vigor and avoid shifts in diet preferences to woody species (Clary and Webster 1990, Clary and Leininger 1997).

Stubble height guidelines generally recommend residual stubble heights ranging between 8 to 15 cm. Hall and Bryant (1995) felt that undesirable impacts from livestock grazing could be avoided by maintaining residual stubble heights near 8 cm. The authors noted that cattle diet preferences are likely to change when an 8 cm stubble height is approached. Similarly, Kauffman et al. (1983) observed that livestock diet preferences generally did not shift towards shrubs when a 10 cm stubble height remained. Additional stubble height recommendation were made by Clary and Webster (1990) for the Intermountain Region in the western United States. The authors recommended minimum stubble heights ranging from 10-15

cm at the end of the growing season. In addition, Meyers (1989) reported that residual stubble heights of 15 cm, coupled with vigorous woody plant growth was typical of riparian areas in good and excellent condition.

The information obtained from this present study should be widely applicable throughout the West, as the study site for this research project is similar to sites found in California (Ratliff and Westfall 1987, Huber et al. 1995), Wyoming (Costello 1944), Montana (Marlow and Pogacnik 1985), Utah (Platts and Nelson 1989), Oregon (Roath and Krueger 1982), and Idaho (Clary and Booth 1993). It is hoped that this information can be used to develop grazing management strategies that promote a desirable mix of vegetation that best meets management goals.

Study Site

The study site was located on the Sheep Creek Grazing Allotment in northcentral Colorado, 80 km northwest of Fort Collins. The Allotment is within the Roosevelt National Forest at an elevation of approximately 2,500 m. Sheep Creek is a 4-5 m wide headwater stream and is classified as a C-3 stream according to Rosgen (1994). Soils in the study area were derived from granitic parent material and are a deep, coarse, sandy to clay loam family of pachic cryoborolls (USDA

Soil Survey 1980). Mean annual precipitation for the region is about 400 mm. Growing season precipitation averages about 240 mm (NOAA 1995).

In 1956, because of severe degradation caused by overgrazing by domestic livestock, the U.S. Forest Service and Colorado Division of Wildlife constructed 3 exclosures to protect the Sheep Creek riparian area. Collectively, these exclosures protect a total of 40 ha along 2.5 km of stream (Schulz and Leininger 1990). Three additional exclosures were built in 1988 encompassing approximately 1.3 ha. At the same time three areas making up 1.8 ha, which had been protected since 1956, were opened to grazing (Popolizio et al. 1994). Since areas with different use histories are present, the Sheep Creek Grazing Allotment provides an excellent opportunity to investigate factors of riparian management.

The overstory vegetation of the site is comprised mainly of several willow species. These include planeleaf willow (*Salix planifolia* Pursh.), Geyer's willow (*S. geyeriana* Andersson), yellow willow (*S. lutea* Nuttall), and sandbar willow (*S. exigua* Nuttall). The understory is a sedge dominated community. Water sedge (*Carex aquatilus* Wahlenberg) and beaked sedge (*C. utriculata* Boott) are dominant, while Nebraska sedge (*C. nebrascensis* Dewey) is found on drier sites of the riparian zone. Grasses found on the site include

bluejoint reedgrass (*Calamagrostis canadensis* (Michaux) P. Beauvois), bluegrass (*Poa* spp.), tufted hairgrass (*Deschampsia caespitosa* (L.) P. Beauvois), and common Timothy (*Phleum pratense* L.). Several species of forbs were also present, but none were very common.

Several research projects comparing the vegetation characteristics of grazed areas and exclosed areas have been conducted on the Sheep Creek study site. The results from this current project should supplement previous findings, so that useful management strategies for riparian areas can be developed. Popolizio et al. (1994) completed a study after the new sites were created in 1988. Thus, they compared areas that had been long-term grazed, long-term protected (since 1956), recently protected and recently grazed sites. They found canopy cover of legumes to be significantly higher in the long-term grazed areas compared to the other sites. The authors also noted a greater proportion of native species growing within the long-term protected areas. Percent foliar cover of sedges, however, was not different among treatments. In addition, the authors found that 2 years of protection of long-term grazed areas resulted in increased litter accumulation, decreased bare ground, and increased foliar cover of grasses and sedges.

In another study, Schulz and Leininger (1990) compared

canopy coverage, density, and standing crops of riparian species between grazed and ungrazed areas. This research was completed before the fencing activities in 1988. They found that mean peak standing crop and total vegetation cover were greater in the ungrazed areas as compared to the grazed areas. Litter cover was also higher in the protected areas. Possibly the most significant finding was that long-term, heavy, season long cattle grazing limited willow size, but not willow density. Willow canopy coverage was found to be 8 1/2 times greater in ungrazed areas versus grazed areas, while willow density was not significantly different between the 2 sites. Important forage species responded differently to grazing treatments. Kentucky bluegrass (*Poa pratensis*) was favored by cattle grazing, while fowl bluegrass (*Poa palustris*) was favored by protection. Nebraska sedge, beaked sedge, and tufted hairgrass coverages were not different between the grazed and ungrazed areas.

Recent studies on the same study site investigated the effects of livestock grazing on willow vigor and willow susceptibility to damage. Billig (1992) measured the number of willow stems per clump, the number of willow clumps, and the height of each clump. The author felt that willow height and willow density could be used to measure vigor and replacement, respectively. Billig concluded that willow

stands along Sheep Creek were increasing in vigor, while little replacement had taken place since the study was initiated in 1988.

In a study that investigated the effects of clipping on planeleaf willow, Lamman (1994) reported that this willow species could be adversely affected by heavy defoliation. This was especially true during the summer months. However, the author concluded that planeleaf willow could withstand moderate use during the spring and fall treatment periods. Defoliation during the spring period allowed planeleaf willow plants an opportunity for regrowth, while fall defoliation occurred after willow plants had translocated enough nutrients belowground to maintain plant vigor.

Intact aquatic ecosystems with abundant streamside vegetation insure healthy fish populations (Kauffman and Krueger 1984). In comparing trout habitat and abundance between protected and heavily grazed areas along Sheep Creek, Stuber (1985) found that fishing opportunities within the exclosed portions were much greater than that of unfenced areas. In addition more game fish were found in fenced areas, while nongame fish were more common in unfenced areas. Sheep Creek was narrower and deeper in the fenced areas, thus providing better trout habitat. Overall, Stuber (1985) concluded that protection from livestock grazing has resulted

in excellent trout habitat conditions, much higher trout standing crop, and greater fishing opportunity than in adjacent heavily grazed areas.

OBJECTIVES AND HYPOTHESES

The overall objective of this study was to quantify the relationship between the availability of herbaceous forage and cattle diet selection in the riparian zone. A secondary objective was to determine if the relationship between diet selection and forage utilization is similar throughout a growing season. Significant differences in diet selection between herbaceous and woody components of the riparian community were expected as the grazing season progressed and as utilization levels increased. It was expected that willow use would be greatest in the fall grazing period and would increase within each grazing season as high utilization levels reduced the availability of herbaceous vegetation.

The following specific hypotheses were developed:

H01: Consumption of woody species by cattle will remain the same as the grazing season advances.

H1: Consumption of woody species by cattle will increase as the grazing season advances.

H02: Willow consumption by cattle will remain the same as decreasing stubble height reduces the amount of available biomass.

H2: Willow consumption by cattle will increase as decreasing stubble height reduces the amount of available biomass.

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CHAPTER 2

THE EFFECTS OF SEASON OF USE AND HERBACEOUS STUBBLE HEIGHT ON DIET SELECTION BY STEERS IN A MONTANE RIPARIAN ZONE

Introduction

Riparian areas in the western United States have historically been recognized for their multiple-use values. Riparian ecosystems are highly prized by wildlife managers because of the structurally diverse habitat they provide. At the same time, riparian ecosystems are praised by livestock managers for the abundant forage they provide. The general public has also become aware of the importance of riparian ecosystems because of the high recreational potential found within these areas (Armour et al. 1994). Recent research efforts have been integrated programs designed to produce information that will guide resource managers toward improving the status of degraded riparian areas (Popolizio et al. 1994). In spite of the recent attention directed towards riparian ecosystems by researchers, there is still little information about livestock management in riparian areas currently available to resource managers (Baker and Leininger 1992).

It has been documented that community selection by cattle reflects the higher availability and greater succulence of forages in riparian areas as compared to uplands (Senft et al. 1985, Pinchak et al. 1991, Smith et al. 1992). These findings may help explain the preference shown by cattle for riparian ecosystems, since these systems typically have higher forage production and forage succulence compared to the surrounding areas. This preference often leads to over utilization and eventually compromises the ecological integrity of riparian ecosystems (Pinchak et al. 1991).

Although there have been numerous studies investigating livestock distribution (Bryant 1982, Roath and Krueger 1982, Marlow and Pogacnik 1986, Pinchak et al. 1991, Clary and Booth 1993) and vegetation utilization (Kauffman et al. 1983, Platts and Nelson 1985, Smith et al. 1992) within the riparian zone, few have directly addressed cattle diet selection (Huber et al. 1995) within these ecosystems. In addition, information on how residual stubble height affects livestock diet selection within riparian areas is absent in the literature.

The overall objective of this study was to determine if willow (*Salix* spp.) consumption by cattle in the riparian zone was more closely related to the season of use or to the residual stubble height of the herbaceous forage. It was expected that willow consumption would be greatest in the fall

grazing period and would increase within each grazing season as high utilization levels reduced the stubble height and availability of herbaceous forage.

Materials and Methods

The study site was located on the Sheep Creek Grazing Allotment in north-central Colorado, about 80 km northwest of Fort Collins. The Allotment is located within the Roosevelt National Forest at an elevation of approximately 2,500 m. Sheep Creek is a 4 to 5 m wide stream and is classified according to Rosgen (1994) as a C-3 stream. The soils in the study area are classified as Naz 70, a coarse loamy pachic cryoboroll derived from weathered granite. Naz 70 is usually deep and well drained with an A Horizon that is very dark, grayish brown and sandy loam or clay loam in texture (USDA Soil Survey 1980).

Sheep Creek was heavily grazed by domestic livestock from the 1890's to 1956, at which time 3 large grazing exclosures were constructed by the U.S. Forest Service and the Colorado Division of Wildlife. These exclosures encompass 40 ha of riparian meadows along 2.5 km of stream (Popolizio et al. 1994). Livestock grazing has been excluded within the exclosures since their construction in 1956. The grazing paddocks used in this investigation were located within these exclosures.

Average annual precipitation at Red Feather Lakes, approximately 15 km to the southwest of the study site, is about 41 cm. Nearly 60% of the annual precipitation falls during the May through September period. The long-term average precipitation during this period is about 24 cm. During the May through September period in 1995 when the study was conducted, the weather station in Red Feather Lakes recorded nearly 36 cm of precipitation (NOAA 1995).

The research paddocks (approximately 0.25 ha) were located within the larger grazing exclosures that were constructed in 1956. The paddocks were selected based on the proportion of willow canopy coverage (1/3) and the similarity of the understory vegetation. There were a total of 12 research paddocks, with 3 paddocks (i.e., 3 replications) being grazed during each of the 4 grazing seasons. The season and order in which each of the 12 research paddocks were used was randomly chosen. The grazing periods were spring, early-summer, late-summer, and fall. These grazing periods corresponded to the following phenological stages of planeleaf willow: flowering and leaf emergence, full leaf expansion, mature leaf clusters, and leaf senescence.

The understory vegetation in the research paddocks is a sedge (*Carex* spp.) dominated community. Water sedge (*Carex aquatilus* Wahlenberg) and beaked sedge (*C. utriculata* Boott)

are dominant species, while Nebraska sedge (*C. nebrascensis* Dewey) is found on drier microsites. Grass and grass-like species found on the study site include bluejoint reedgrass (*Calamagrostis canadensis* (Michaux) P. Beauvois), bluegrass (*Poa* spp.), tufted hairgrass (*Deschampsia caespitosa* (L.) P. Beauvois), common Timothy (*Phleum pratense* L.) and rushes (*Juncus* spp.). Forbs were only a minor component of the vegetation, with cinquefoil (*Potentilla* spp.) and white clover (*Trifolium repens* L.) as the most common species. Shrubby cinquefoil (*Pentaphylloides floribunda* (Pursh) Love) was the only common shrub within the understory.

The overstory vegetation of the study area was dominated by several willow species. These include planeleaf willow (*Salix planifolia* Pursh.), Geyer's willow (*S. geyeriana* Andersson), yellow willow (*S. lutea* Nuttall), Sandbar willow (*S. exigua* Nuttall), and peach-leaved willow (*S. amygdaloides* Andersson).

Vegetation biomass at the beginning of each grazing period was determined by clipping to ground level ten 0.25 m^2 quadrats, located along 4 random transects in each grazing paddock. Available biomass of current year's growth of the willows within the 0.25 m^2 quadrats was also collected. Available willow biomass was defined as current year's growth rooted within the 0.25 m^2 quadrats that was within 2 m of

ground level. Current year's growth not available to the steers was not sampled. All vegetation samples were oven-dried at 55° C for 48 hours to obtain dry weights.

The botanical composition of cattle diets was sampled during 4 grazing periods in 1995 using 5 esophageally fistulated holstein steers. It has been determined that esophageally fistulated animals give the most reliable estimate of diet composition of any of the common methods used (Laycock et al. 1972, Holechek et al. 1982). Prior to diet sample collection, the experimental animals were allowed to graze areas adjacent to the research paddocks so that they could become familiar with the vegetation found on the site. In addition, the same experimental animals were used the previous year for a related study at Sheep Creek.

Diet samples were collected at zero, low, moderate, and high levels of herbaceous utilization. The level of herbaceous utilization was determined using stubble height measurements following Kinney and Clary (1994). Stubble height measurements were taken every 0.5 m along 5 randomly located 10 m transects in each paddock. Herbaceous species that were measured for stubble height included water sedge, beaked sedge, bluejoint reedgrass and Kentucky bluegrass (*Poa pratensis* L.). The level of utilization was determined for each species measured. A weighted average utilization level

for the paddock was then calculated. Stubble height measurements were taken prior to sampling steer diets so that appropriate utilization levels were obtained.

At zero use, the steers were introduced to the paddocks and a diet sample taken. Following the sample period, the steers were allowed to graze the paddock until herbaceous utilization was about 15% (i.e., a low level of use). Diet samples were again collected from each steer. After the second sampling period, the steers were allowed to graze the paddock until herbaceous utilization was about 35% (i.e., a moderate level of use), at which time diet samples were collected. The final diet sample was collected after the paddock had received a high level of use (>50% utilization). The diet sampling period for each steer during each collection period was approximately 20 minutes. This was the maximum time available to insure that the fistulas did not shrink and become irritated when reinserting the canula.

After collection, diet samples were washed, refrigerated, and frozen as soon as possible. The frozen diet samples were then processed and slides prepared following Sparks and Malechek (1968). Botanical composition of the diet samples was determined using the microhistological technique of Theurer et al. (1976). Data were analyzed using the MIXED procedure of the Statistical Analysis System (SAS) with a

factorial arrangement of treatments within a completely randomized design (SAS 1990). The fixed effects tested were 4 periods of grazing (season), 4 levels of utilization (stubble height) and the season x utilization interaction. The rep and steer effects and their associated interactions were treated as random effects. Due to the lack of suitable locations for grazing paddocks, one rep during each grazing season had been previously grazed in the summer of 1994 for a similar research project. Because one rep was previously grazed, a separate analysis treating rep as a fixed effect was performed. To complete the statistical analysis of the diet data, raw data were transformed using an arcsin square root transformation. The p-values associated with the transformed data are reported in the text, while untransformed data values are reported in the figures. Significance was tested at the $p \leq 0.10$ level of significance. Main effects are discussed when there was no significant interaction among main effects.

Results and Discussion

Available Biomass

Current year's herbaceous and shrub biomass available to the steers for consumption during the spring grazing season averaged 1129 kg/ha (Fig. 1). Available biomass increased by approximately 50% to 1657 kg/ha during the early-summer grazing season, and was nearly double the initial value (2855

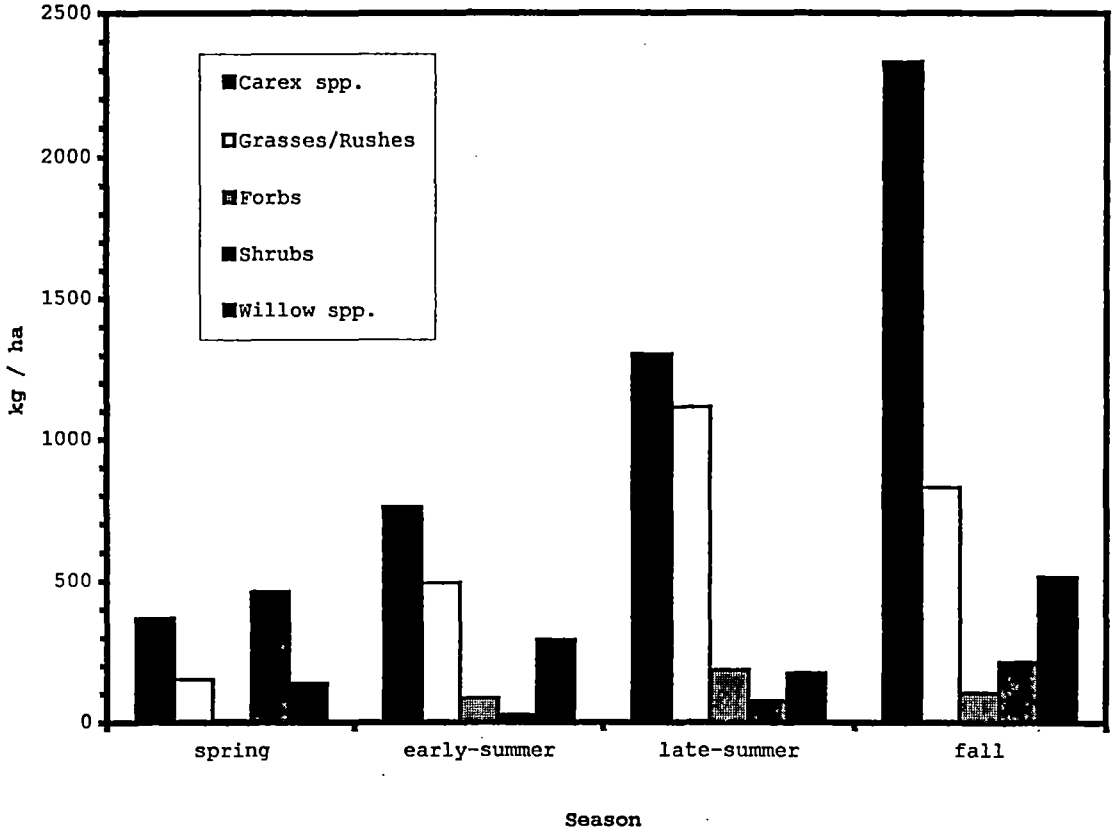

Figure 1: Available biomass to steers, Summer 1995.

kg/ha) by late-summer. During the fall grazing season available biomass was determined to be 3944 kg/ha. All grazing seasons had different amounts of available biomass ($p<0.10$). Previously grazed (i.e., summer of 1994) paddocks did not have different ($p=0.22$) amounts of available biomass than the paddocks which had not been previously grazed. The previously grazed paddocks (which were grouped into Rep 1 for analysis purposes) averaged 2069 kg/ha, while the Rep 2 and Rep 3 paddocks averaged 2348 kg/ha and 2773 kg/ha, respectively.

During the 1995 growing season, the Sheep Creek study site received nearly 1 1/2 times more precipitation than the long-term average. This above average growing season precipitation lead to increased amounts of biomass production. In a study conducted on the same study site, Schulz and Leininger (1990) reported that peak standing biomass was 2410 kg/ha averaged over the two years of their study. On a similar study site in California, Huber et. al (1995) reported biomass values of 1,952 kg/ha and 4,129 kg/ha for streamside locations during the two years of their study.

Seasonal Steer Diets

Willow consumption by the steers was not affected ($p=0.24$) by the season of use. However, there was a trend towards greater use of willows as the season progressed.

Steer diets averaged across all levels of use contained 9% willow species (Fig. 2) during the spring season, as compared to 20% willow species during the early-summer season. Throughout the late-summer grazing season, steer diets included 18% willow species, while the fall season steer diets averaged 24% willow species.

Roath and Krueger (1982) reported that shrub use increased as the grazing season progressed. They found that shrub utilization was very low during the first 4 weeks of the grazing season. They felt that shrub consumption increased as the grazing season progressed because the herbaceous vegetation was maturing and becoming less palatable. Meyers (1989) observed that the utilization of woody species by cattle increased in late-August and remained heavy through the fall period. Data gathered in this study at Sheep Creek appear to support these observations. Willows comprised an important portion of steer diets in my study as soon as the willow leaves were fully expanded. This suggests that shifts in cattle diet selection may occur much earlier in the growing season than traditionally expected.

Similar to willow consumption, sedge consumption was not ($p=0.46$) affected by the season of use. During the spring grazing season, sedges made up 70% of steer diets (Fig. 3), while during the early-summer grazing season sedges averaged

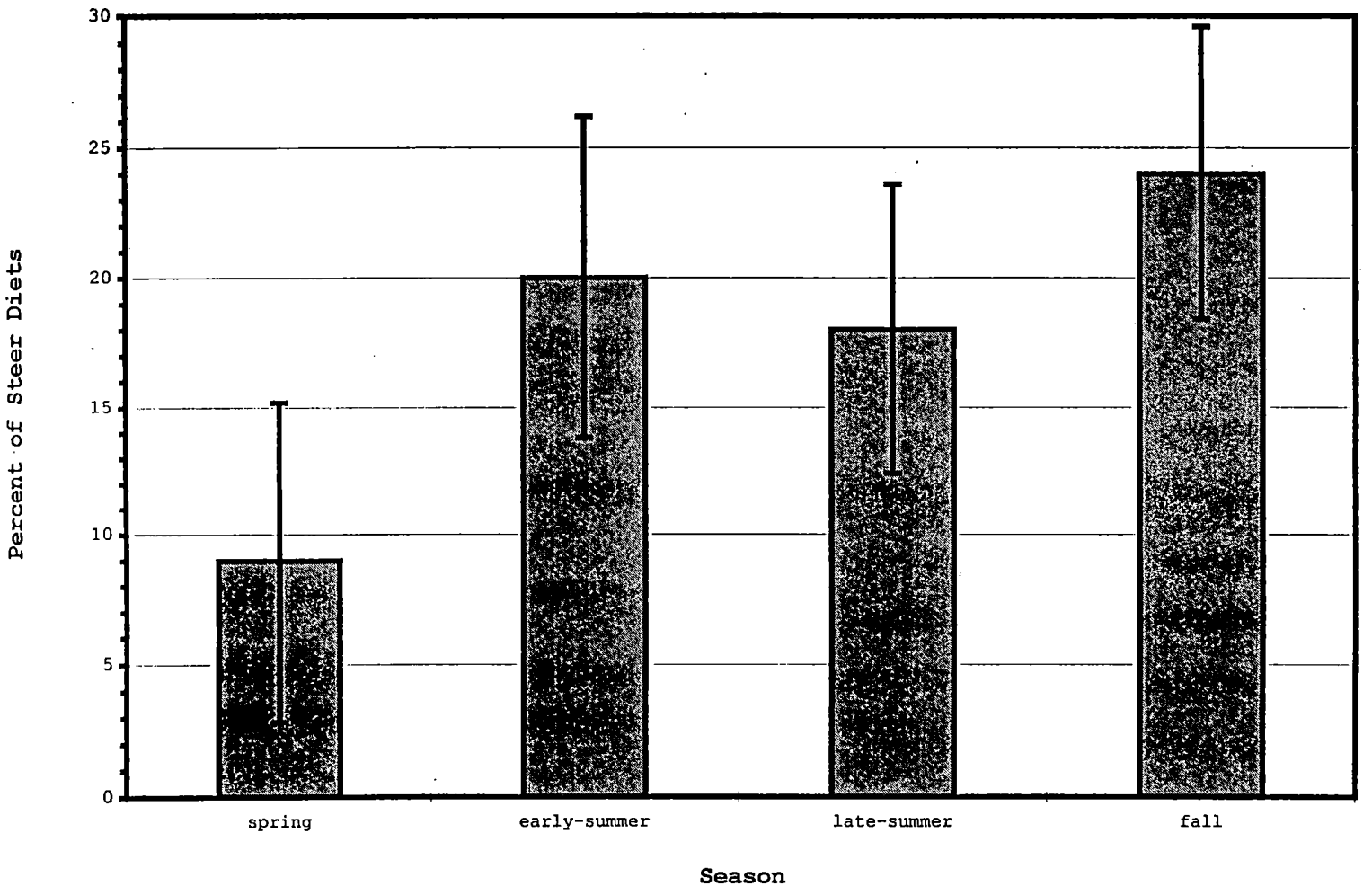

Figure 2: Seasonal willow consumption by steers averaged across 4 levels of use. Values are means $\pm$ 1 standard error.

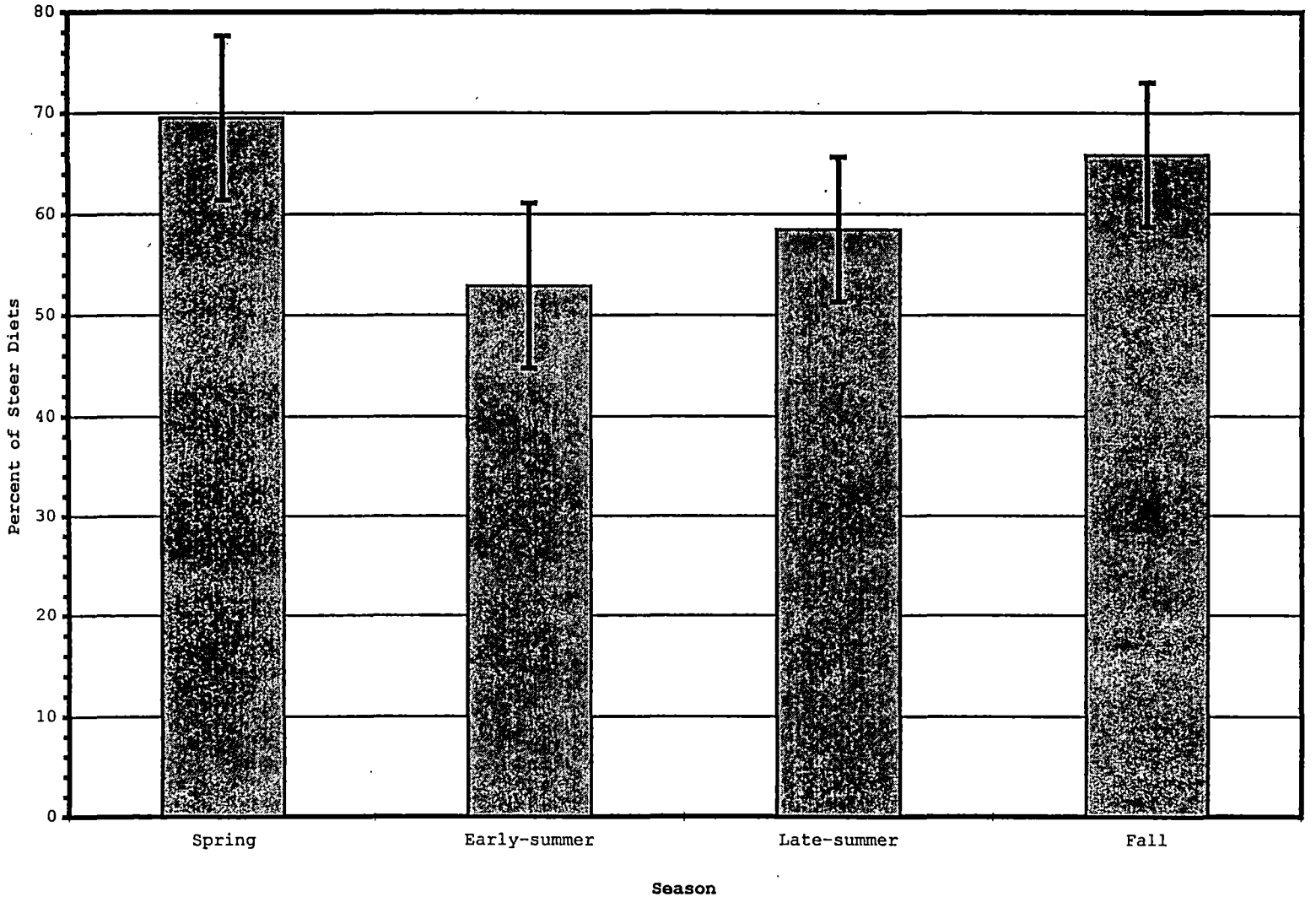

Figure 3: Seasonal sedge consumption by steers averaged across 4 levels of use. Values are means $\pm$ 1 standard error.

53% of steer diets. Similarly, sedges made up 58% of steer diets throughout the late-summer grazing period and 66% of steer diets during the fall grazing period.

In a study in California, Huber et al. (1995) reported that grass-like species increased in cattle diets throughout the growing season. They attributed this shift in diet preference to the decreased palatability of grasses as the grazing season progressed. In my study, sedge composition in steer diets remained at a relatively high level among the 4 seasons examined. In the research paddocks, the understory vegetation was a sedge dominated community. Sedges typically made up about 60% of the understory vegetation composition. Undoubtedly, this had a major affect on the amount of sedges in the steers' diets.

Grass and rush (*Juncus* spp.) consumption by the steers was not influenced ($p=0.14$) by the season of use. Grass and rush consumption (Fig. 4) was numerically highest during the early-summer grazing period, comprising 25% of steer diets. In contrast, grass and rush consumption was numerically lowest during the fall grazing period making up only 7% of steer diets. Grasses and rushes made up 16% and 15% of steer diets during the spring and late-summer grazing periods, respectively.

Huber et al. (1995) reported that grass consumption

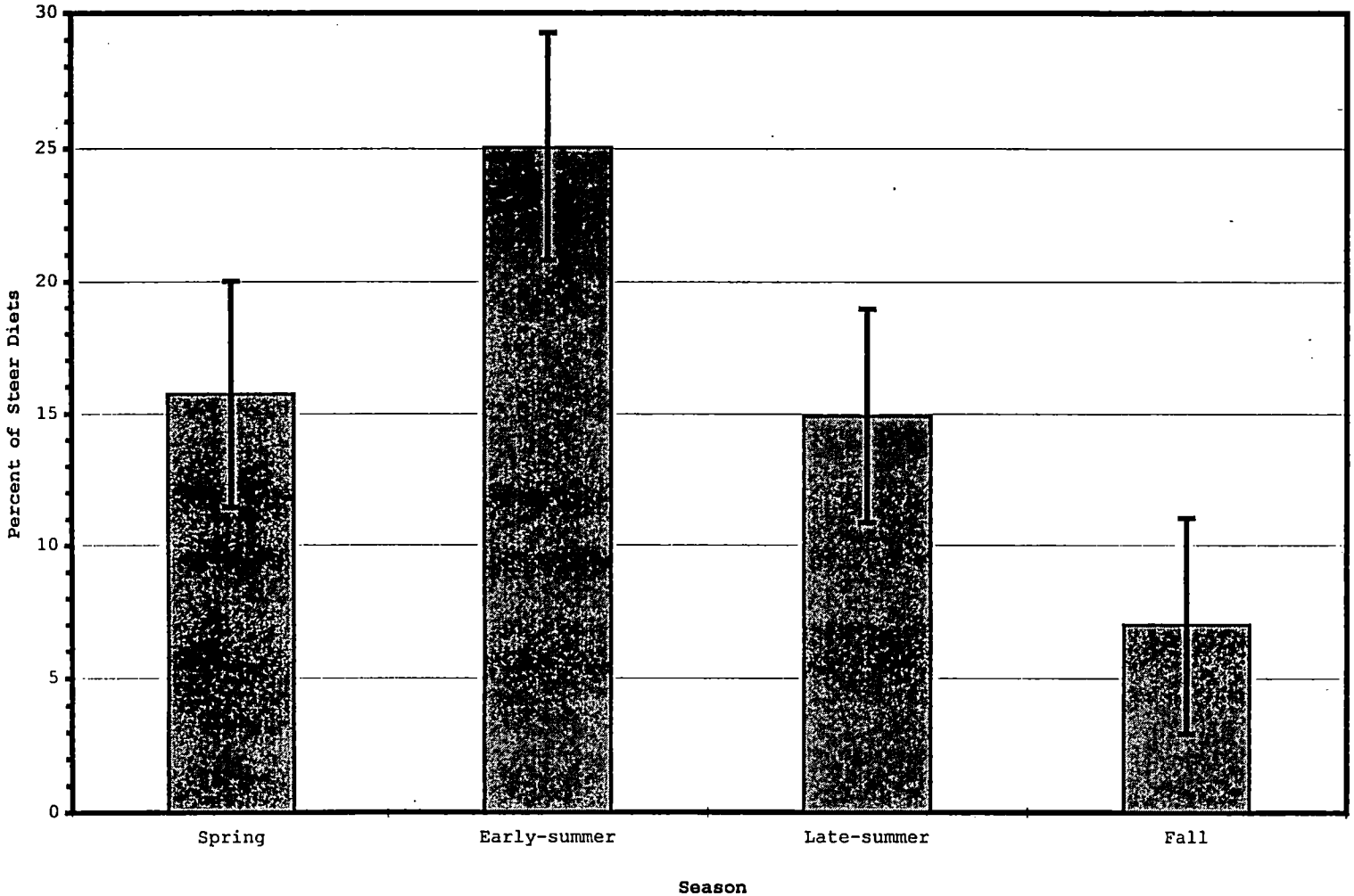

Figure 4: Grass and rush consumption by steers averaged across 4 levels of use. Values are means $\pm$ 1 standard error.

declined throughout the growing season. They attributed their results to the effects of advancing plant maturity. In my study, grass and rush consumption tended to increase until the early-summer period and then began to decline. It appears that forage quality relationships were a significant factor in this pattern. The highest consumption of grasses and rushes was during the early-summer grazing period, which corresponded to the high forage quality stage of these species. The lowest consumption of grasses and rushes was during the fall grazing period, which corresponded to the period when these forage species were highly lignified.

Forb consumption by the steers was most affected ($p=0.05$) by the season of use. Forbs made up only 1% of steer diets (Fig. 5) during the spring grazing season and 3% of steer diets during the early-summer grazing period. Forb consumption was the highest during the late-summer grazing period when forbs comprised 9% of steer diets. During the fall grazing period forbs comprised 3% of steer diets.

Holechek et al. (1982) reported that cattle preference of forbs was greatest early in the growing season and shifted to grasses as phenology advances and grasses become relatively more palatable. Huber et al. (1995) also reported that forb consumption by cattle grazing a riparian zone decreased as the growing season progressed. Forb consumption by the steers in

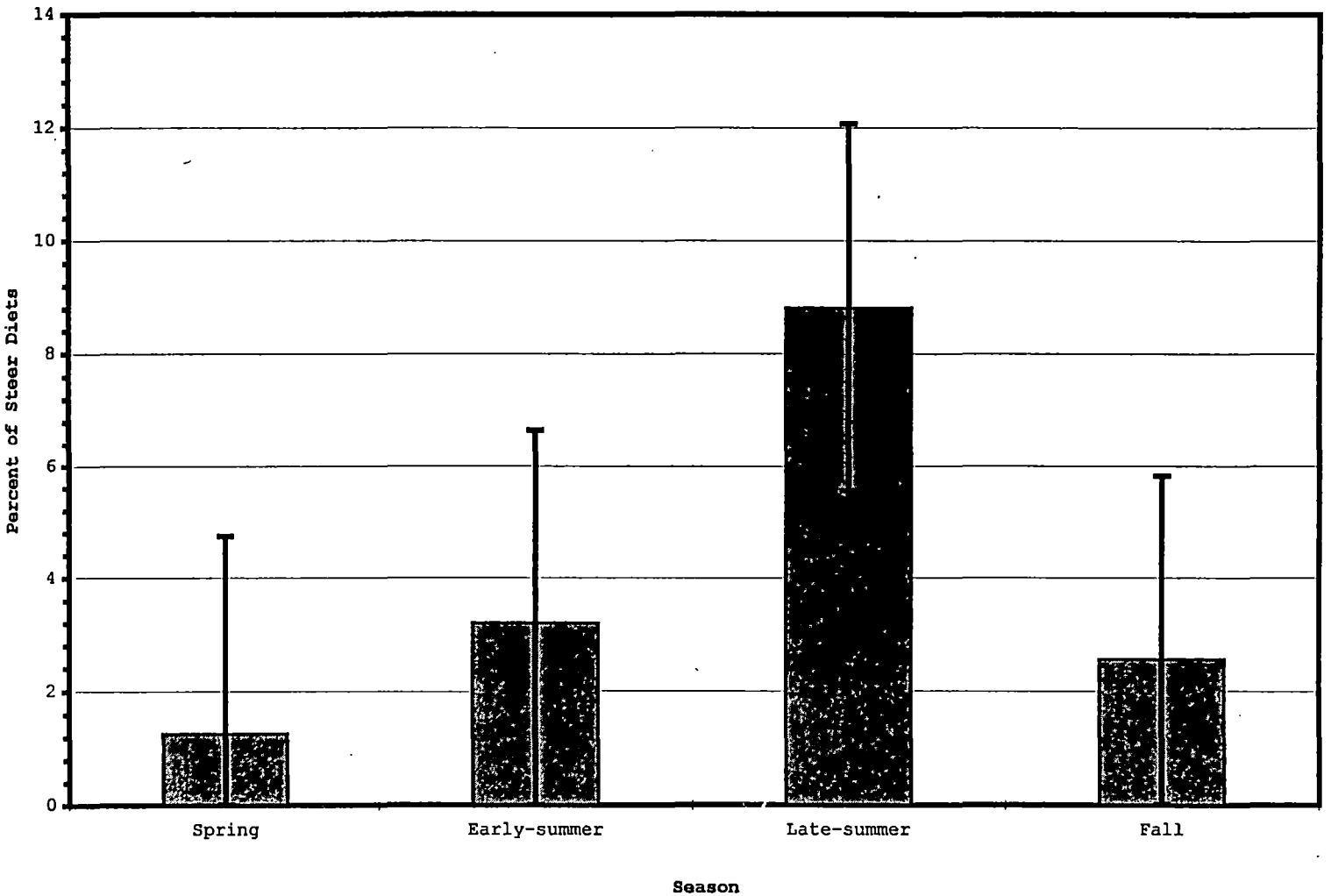

Figure 5: Forb consumption by steers averaged across 4 levels of use. Values are means $\pm$ 1 standard error.

this present study closely followed the same trend as forb biomass. Forb biomass available (185 kg/ha) to the steers was high during the late-summer grazing period when compared to the other 3 grazing seasons. During the spring season forb biomass averaged only 8 kg/ha, while during the early-summer season forb biomass available to the steers was 84 kg/ha. Forb biomass during the fall grazing season was 104 kg/ha. Holochek et al. (1982) reported that livestock were very opportunistic in their grazing habits. My results appear to support their findings.

Steer Diets as a Function of Stubble Heights

The reduction in residual stubble height was the most important factor ($p=0.01$) contributing to willow consumption by the steers. Willow consumption at all utilization levels was statistically different from one another, except between ZERO and LOW ($p=0.14$) and between the LOW and MOD ($p=0.26$) levels of herbaceous utilization. When no previous use (ZERO) had occured (mean stubble height = 45 cm), willows made up only 2% of steer diets (Fig. 6) averaged across all grazing seasons. When a LOW level of use (mean stubble height = 25 cm) had occured, willows comprised about 12% of steer diets. At a MOD level of use(mean stubble height = 17 cm), willows comprised 21% of steer diets. As expected, willow consumption was highest when a HIGH level of use (mean stubble height = 14

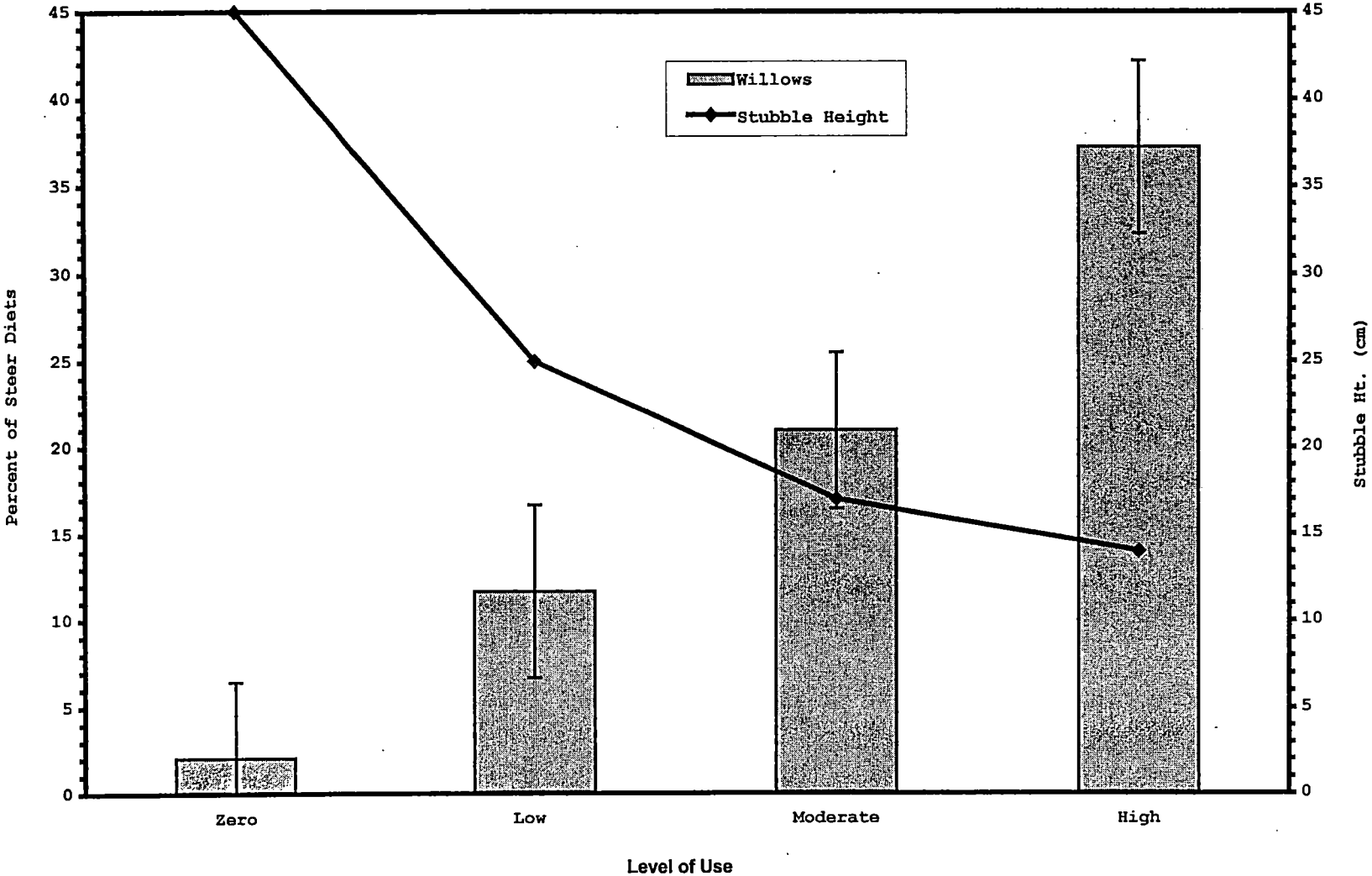

Figure 6: Willows in steer diets as a function of stubble heights during Summer 1995. Values shown are means $\pm$ 1 standard error.

cm) had occured. At this level of use, willows were 37% of steer diets.

There is little empirical evidence in the literature that suggests willow consumption increases as the level of herbaceous use increases. However, Kauffman et al. (1983) reported observations indicating that browsing by cattle increased throughout the growing season. They felt that increased browse consumption was because current utilization levels limited the availability of preferred herbaceous forages. In addition, the authors noted that a shift to shrub use generally does not occur if 10 cm of herbaceous stubble remains. However, the authors also felt that highly palatable shrubs may be utilized before 10 cm stubble heights were attained. Similarly, Meyers (1989) noted that the utilization of woody species appeared to increase as the duration of grazing treatments increased. The author felt that the increased browse utilization was in response to declining herbaceous forage availability. In addition, Meyers reported that stubble heights greater than 15 cm may be necessary to protect riparian ecosystem function.

My data suggest that willow consumption sharply increases as stubble heights approach 15 cm. At the Sheep Creek study site, utilization levels averaged approximately 40% at a 15 cm stubble height. Clary and Webster (1989) also reported data

that related stubble heights to percent herbaceous utilization. Their data indicated that utilization levels of 24 - 32% were obtained when herbaceous stubble heights were 15 cm. These differences illustrate that the level of utilization at a specific stubble height will change depending upon site characteristics and potential.

Contrary to the pattern in willow consumption, sedge consumption was not affected ($p=0.11$) by the level of herbaceous utilization. When ZERO use had occured (mean stubble height = 45 cm), sedges comprised nearly 80% of steer diets (Fig. 7). When the level of herbaceous utilization increased to a LOW level of use (mean stubble height = 25 cm), sedge composition in steer diets averaged 64%. Similarly, after a MOD level of herbaceous utilization (mean stubble height = 17 cm) had occured, sedge species made up about 55% of steer diets. When herbaceous utilization was increased to >50% (mean stubble height = 14 cm) sedges comprised 48% of steer diets. The consistent trend shown in Fig. 7 towards a decrease in sedge consumption by the steers as the season progressed was probably caused by the increase in willow consumption by the experimental animals.

My results support the findings by Huber et al. (1995). They noted that the consumption of grass-like forages was little affected between low and moderate levels of use. The

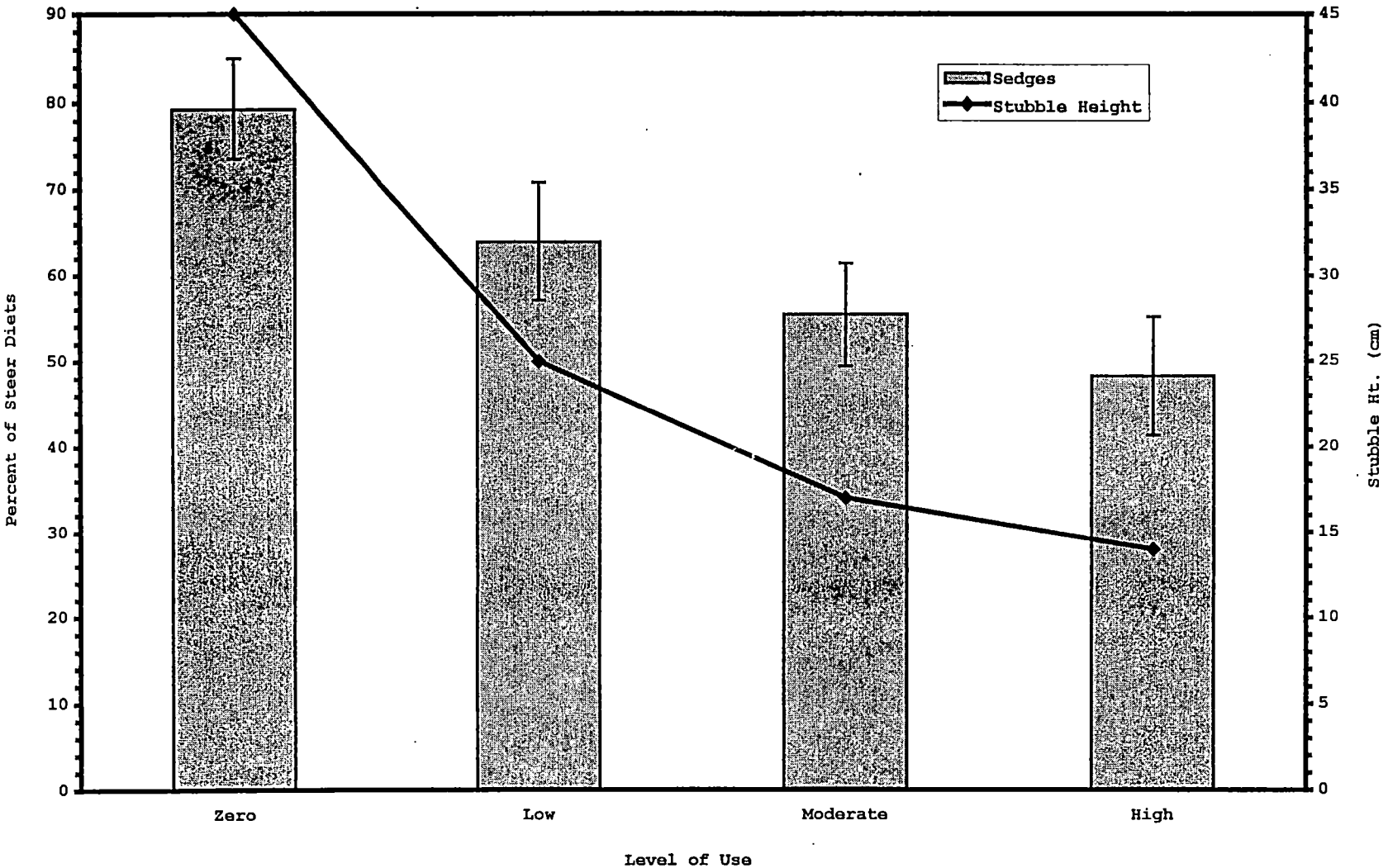

Figure 7: Sedges in steer diets as a function of stubble heights during Summer 1995. Values shown are means $\pm$ 1 standard error.

authors reported that grazing behavior and area of use within the pastures for grazing and loafing were altered by stocking density.

Of the treatments evaluated, grass and rush consumption was most strongly affected by the reduction in residual stubble height. This effect was the only main effect that had a significant influence ($p=0.01$) on grasses and rushes in steer diets. At the ZERO level of herbaceous utilization (mean stubble height = 45 cm), grasses and rushes comprised 13% of steer diets (Fig. 8). Consumption of grasses and rushes by the steers increased ($p=0.002$) when a LOW level of use (mean stubble height = 25 cm) had occurred by nearly 10% and comprised 22% of the diets selected by the steers. When use levels were increased to a MOD level, grasses and rushes in the steer diets began to decline ($p=0.09$). At a MOD level of herbaceous utilization (mean stubble height = 17 cm), 17% of the steer diets were made up of grasses and rushes. At HIGH levels of use (mean stubble height = 14 cm), grass and rush consumption continued to decrease and was only 11% of steer diets. The smallest amount of grasses and rushes were consumed during this period. Consumption was lower ($p=0.006$) at the HIGH level than at a LOW level of herbaceous utilization when the most grasses and rushes were consumed.

Huber et al. (1995) detected no significant differences

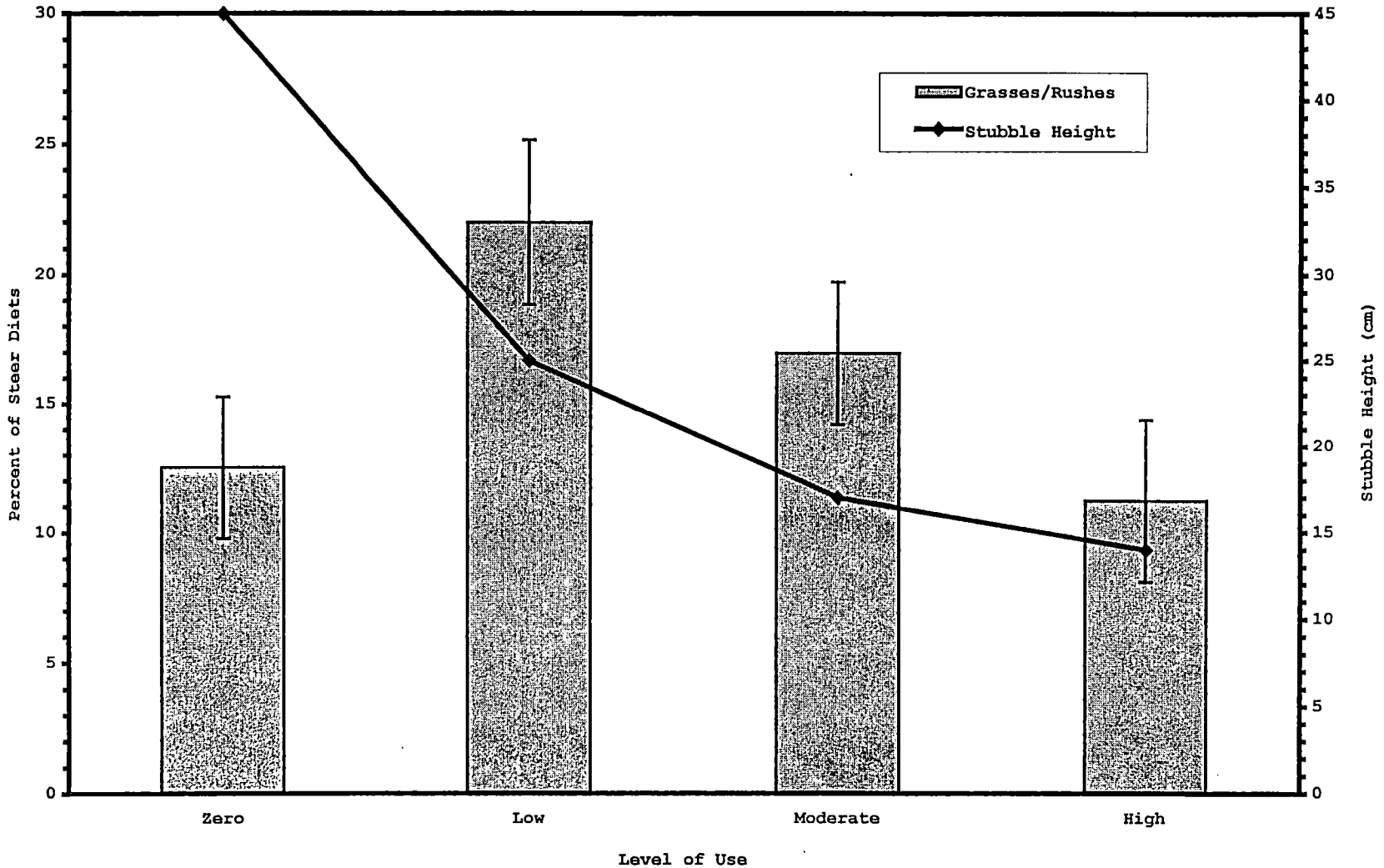

Figure 8: Grasses and rushes in steer diets as a function of stubble heights during Summer 1995. Values shown are means $\pm$ 1 standard error.

in cattle diet selection between low and moderately stocked research pastures. In their study the low and moderate levels of use corresponded to residual biomass levels of 1,000 and 1,500 kg/ha, respectively. My data suggests that some diet selection shifts do occur as the level of use increases. The increase in grass and rush consumption between the ZERO and LOW levels of use had occurred may have transpired because the canopy had become more open and the plants were easier to locate.

Forb consumption by steers was quite variable and was not influenced ($p=0.18$) by the reduction in residual stubble heights. At the ZERO level of use, forbs made up approximately 6% of steer diets (Fig. 9). Forbs declined numerically in steer diets when levels of use were LOW (stubble height = 25 cm) and MOD (stubble height = 17 cm) compared to the ZERO level of use. At these levels of use forbs made up approximately 3% of steer diets. At a HIGH level of use (stubble height = 14 cm) forbs were approximately 4% of steer diets.

Huber et al. (1995) found no treatment differences in the botanical composition of cattle diets as the level of utilization increased. The study by Huber et al. is the only study found in the literature that investigated the effects of herbaceous utilization on cattle diets in the riparian zone.

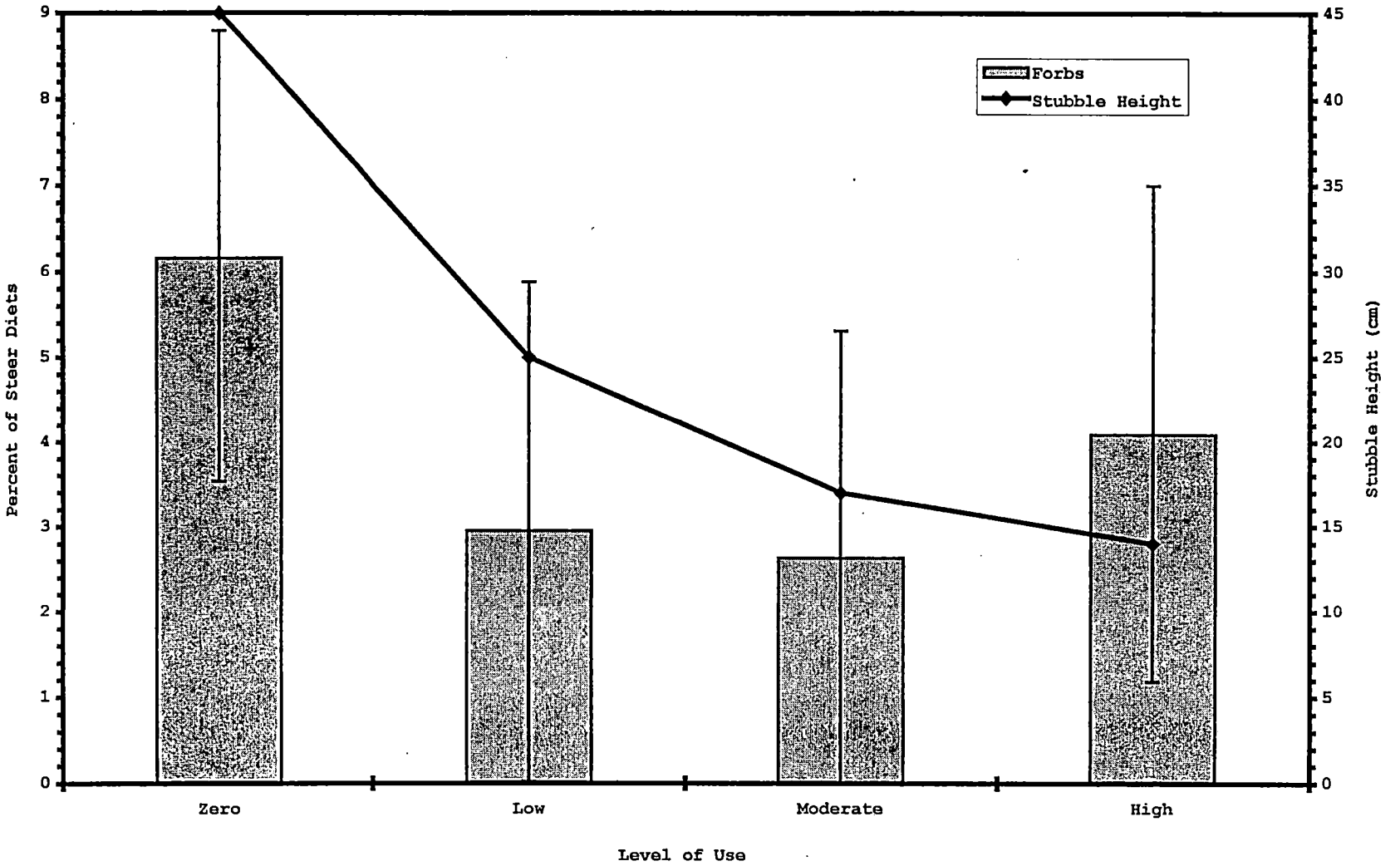

Figure 9: Forbs in steer diets as a function of stubble heights during Summer 1995. Values shown are means $\pm$ 1 standard error.

Similarly, I found no significant effects on forb consumption by cattle in the riparian zone due to increased levels of use.

Season x Utilization Interaction

Although the season x utilization interaction did not significantly affect willow consumption by the steers (p=.053), the data show some interesting trends (Fig. 10). For example, during the spring and early-summer grazing seasons, willow consumption increased at stubble heights within the 10-15 cm guideline. In contrast, willow consumption during the late-summer and fall grazing periods increased at stubble heights of 20 and 23 cm, respectively. This suggests that higher residual stubble heights must be maintained to minimize willow consumption when late season grazing is implemented.

Of the factors tested in this study, the season x utilization interaction proved to have the most sifnificant effect (p=0.02) on sedge consumption. Sedge consumption did not remain the same throughout the growing seasons over all levels of use (Fig. 11). During the spring and early-summer grazing seasons, sedge consumption consitently decreased until a MOD level of herbaceous utilization had occured. Sedges in the steer diets then increased after a HIGH level of herbaceous utilization had occured. However, throughout the late-summer and fall grazing periods, this same pattern of

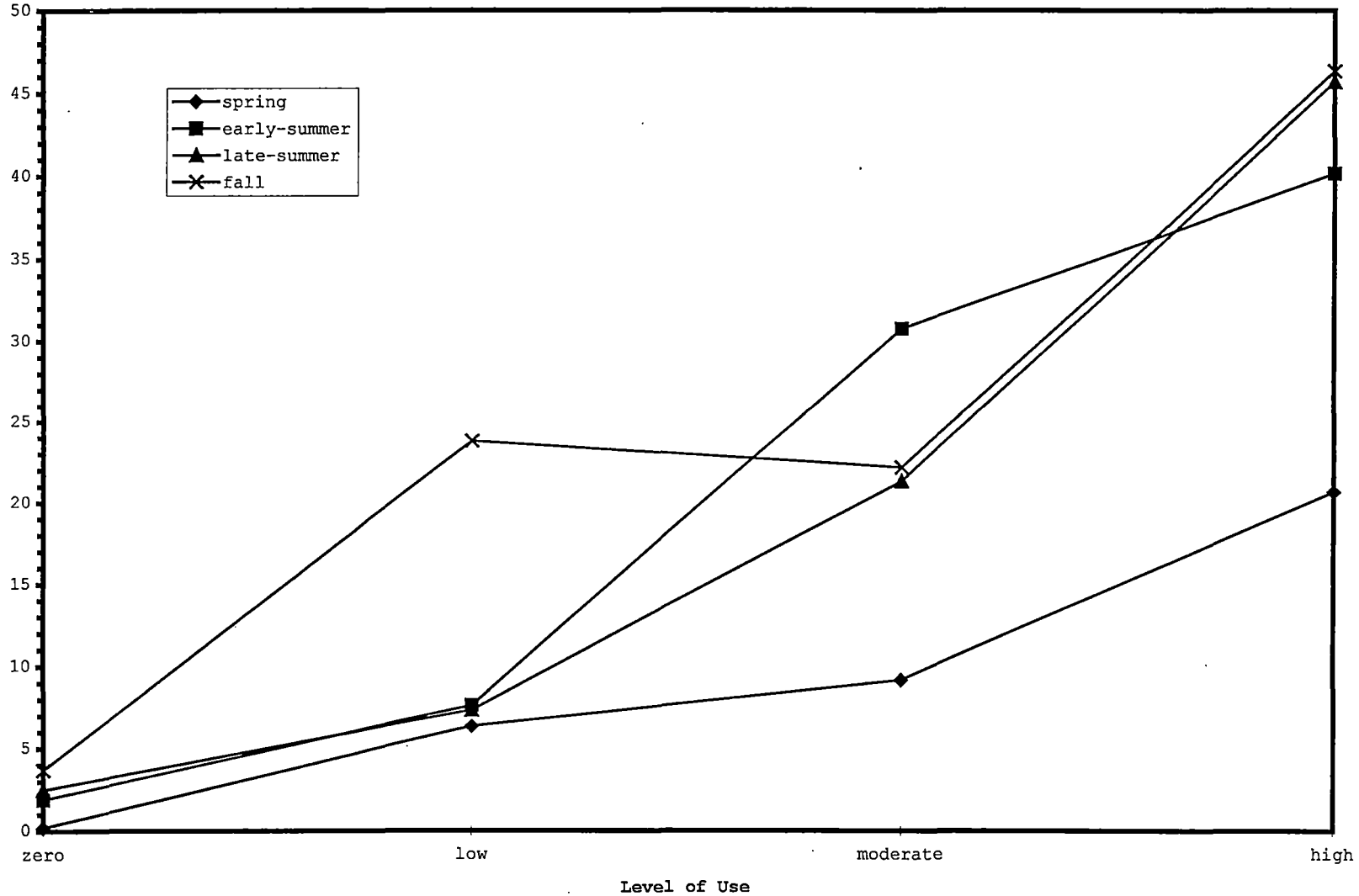

Figure 10: Season x utilization interaction for willows in steer diets, Summer 1995.

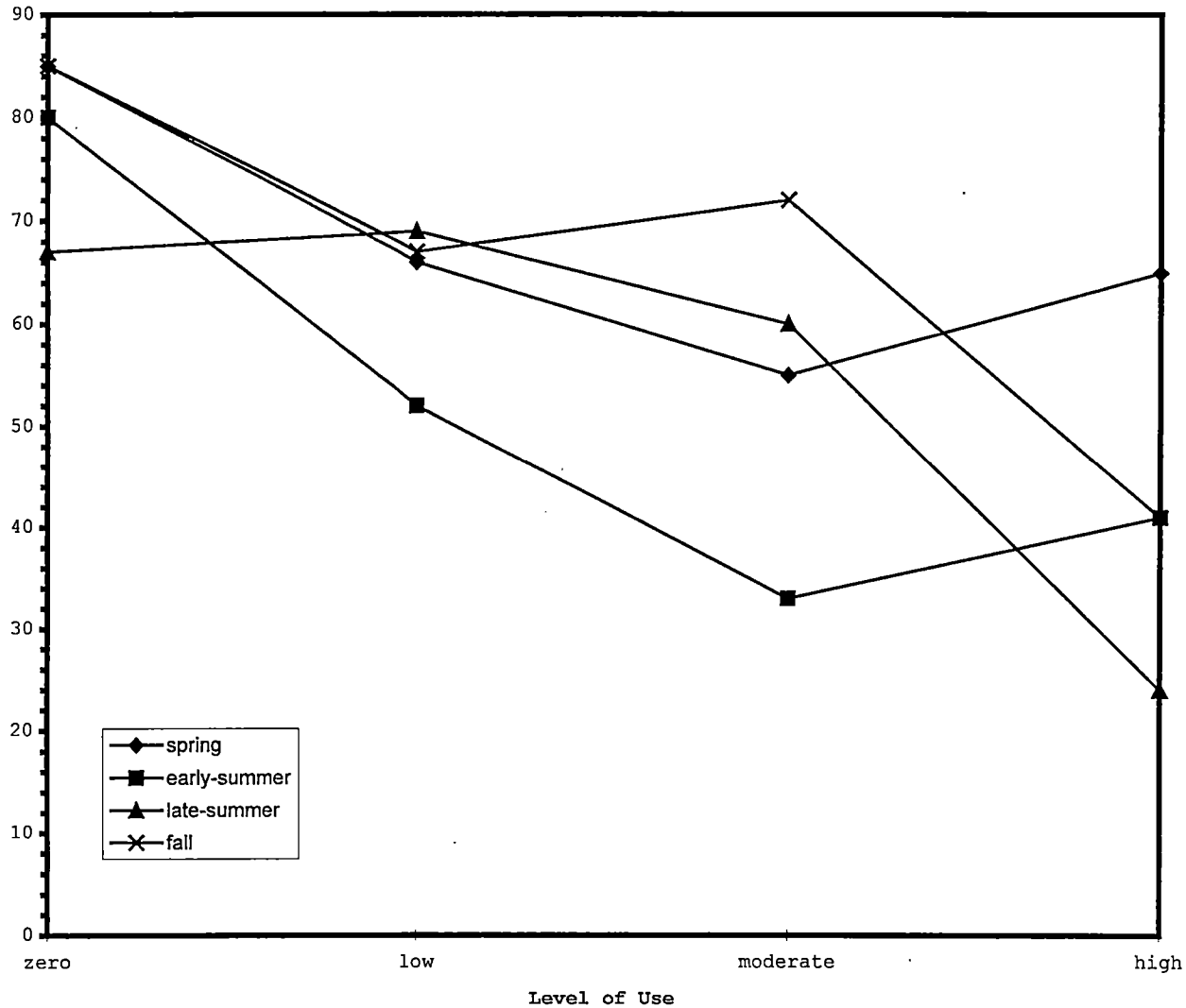

Figure 11: Season x utilization interaction for sedges in steer diets, Summer 1995.

sedge consumption did not occur. Instead of increasing after a MOD level of herbaceous utilization had occurred, sedge consumption to decreased with these 2 treatments.

Random Effects

Of the random effects tested, only willow consumption was significantly affected. The steer x season interaction had an influence ($p=0.06$) on willow consumption. I interpret this to mean that individual animal preferences for willows may not be consistent throughout the growing season. However, I feel that this finding is of little importance since resource managers are most concerned with herd preferences rather than individual animal preferences. However, livestock herds or groups may have preferences for home ranges that include riparian meadows. Roath and Krueger (1982) found that subgroups of cattle herds grazed nearly the same home range in successive years. They suggested that culling the animals that selected riparian areas as home ranges may help decrease the grazing pressure on particular riparian meadows. Likewise, where feasible it may be beneficial to cull animals that prefer wilows.

Management Implications

Protection of the ecological integrity of riparian areas is a complicated issue facing many resource managers. Although grazing activity has the potential to have dramatic impacts to

riparian woody vegetation, my data suggest that carefully controlling the levels of herbaceous utilization by monitoring residual stubble heights can help minimize the consumption of willows by livestock in the riparian zone.

Stubble height measurements appear useful in monitoring the level of use and in determining when diet preferences may change. Data that I have collected suggest that the 10 - 15 cm stubble height guidelines currently in use appear adequate for protection of willows during spring and early-summer grazing. However, during the late-summer and fall seasons stubble heights may need to be maintained near 20 cm to minimize willow consumption. It should also be noted that recommended stubble height guidelines should only be used on sites with similar vegetation communities and biomass production potentials.

My data also suggest that early season (i.e., spring) grazing of riparian pastures may be preferable to late season use. Although the increase in willow consumption as the season progressed was not statistically significant ($p > 0.10$) in this experiment, my data suggest a trend towards increased willow consumption as the growing season progressed.

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CHAPTER 3

LIVESTOCK GRAZING MANAGEMENT TO PROTECT RIPARIAN ECOSYSTEMS

Introduction

Riparian ecosystems may be the most ecological significant habitats in the western United States. These critical ecosystems provide excellent wildlife habitat, provide opportunities for recreational activities, play an important role in protecting surface water quality, and provide excellent sources for livestock forage (Armour et al. 1994). Because riparian areas are valued by so many users, they are subject to the combined impacts of the separate activities. Consequently, healthy riparian areas are important to both resource managers and all of the other associated stakeholders.

The most wide spread impact to riparian zones has been from grazing by domestic livestock (Kauffman and Krueger 1983, Marlow and Pogacnik 1985). While livestock grazing is a legitimate use of riparian habitats, careful management must occur to minimize the detrimental impacts. Livestock cause damage to riparian areas through trampling and the physical removal of vegetation (Benke and Raleigh 1978, Marlow and

Pogacnik 1985, and Clary and Webster 1990). If grazing is excessive riparian vegetation loses vigor and may disappear if management is not improved. The loss or reduction of riparian vegetation leads to changes in streambank morphology, widened stream channels and a subsequent lowering of the surrounding water table (Benke and Raleigh 1978).

One unique characteristic of montane riparian vegetation structure is the typical overstory dominance of willow (*Salix* spp.). This unique overstory undoubtedly contributes significantly to the enhanced ecological value of riparian areas. Willow species contribute to the health of riparian areas by stabilizing streambanks, facilitating the rebuilding of streambanks, and by providing food for aquatic animals and shade which moderates instream water temperature extremes. Unfortunately this component of riparian vegetation structure is usually the first to be negatively impacted by poor livestock management. However, degraded riparian areas are generally restoreable through improved management practices (Chaney et al. 1990).

When developing management strategies for riparian areas there are many factors that need to be considered. Perhaps the most important consideration is the ecological potential of each riparian site. When considering site potential, one should evaluate the factors and interactions that will direct change, what the desired vegetation community should be, and

how livestock and wildlife can fit into the system (Krueger 1996). Management goals should be developed based upon a predetermined site potential.

Once the potential has been determined and management goals have been set, managers can plan livestock grazing to meet the aforementioned goals. When planning grazing strategies, managers should evaluate animal behavior, forage palatability, plant response, plant community changes, hydrology and practicality in the context of vegetation management and grazing (Krueger 1996).

The two most important factors to consider when developing grazing plans for riparian areas are the season of use and the intensity of use. Krueger (1996) felt that the season of use is far more important than the intensity of use. However the author noted that even relatively light levels of use can have significant effects on the growth of shrubs. Clary and Webster (1989) felt that the intensity of use is the most important consideration. The results reported earlier in this publication appear to support the position stated by Clary and Webster (1989). However, managers should consider both opinions valid in the context of setting site specific goals.

The season of use is important because forage palatabilities, as well as soil moisture content generally change as the growing season progresses. These two factors

can have a large influence on the patterns of use and community selection by livestock. The potential for forage regrowth may also be significantly affected depending upon the season of use. Limited regrowth may cause detrimental effects to watershed function and streambank protection, as well as long-term vigor of forage species. In addition, forage species may be more susceptible to damage at different stages of growth (Lamman 1994).

Although the intensity of use undoubtedly affects the potential for regrowth and the susceptibility to damage by grazing, the detrimental effects are generally negligible in riparian areas when reasonable (moderate) levels of use are maintained. Based upon the results reported in Chapter 2, the intensity of use appears to play a significant role in determining when diet preferences may change. This is particularly true for determining when a major diet shift to woody species could possibly occur.

Based on results of diet data with respect to season of use and stubble height (i.e., intensity of use), some recommendations for grazing management can be made. These recommendations focus on grazing management strategies which minimize the consumption of willow species by livestock. Resource managers should incorporate these recommendations into an adaptive, multiple-use management regime.

It appears that the potential for willow consumption is

lowest during the spring grazing season. During this time period the willow species are in the flowering and leaf emergence phenological stage. Although I did not find a statistically significant difference in willow consumption (% of steer diets among grazing seasons), I feel that the increase in preference as the growing season progresses is biologically significant. Willow consumption averaged over all levels of use increased by 100% once the willow leaves were fully expanded (early-summer) and remained relatively constant throughout the rest of the growing season. This suggests that once the willow species have leaf biomass easily accessible to livestock, the potential for detrimental impacts to willow species is present even though the availability of herbaceous forage is not limiting.

Livestock grazing that occurs after full leaf expansion by the willow species should be monitored carefully to ensure that detrimental browsing does not occur. Lamman (1994) found that *Salix planifolia*, an important riparian species, was most susceptible to grazing during the early-summer and late-summer periods. During this window of susceptibility, weather and changes in vegetation palatabilities influence the patterns of habitat use by domestic livestock and generally cause livestock to concentrate in riparian areas (Clary and Webster 1989).

When managing livestock grazing in riparian areas, it is

important to know when diet preferences may change to woody vegetation. Monitoring residual stubble heights appears to be a useful tool for this purpose. The data I have collected suggest that woody species in steer diets greatly increases at stubble heights which correspond to moderate (30-40%) levels of use. At the Sheep Creek study site, diet shifts occurred in the 10-15 cm stubble height range during the spring and early-summer grazing season. Throughout the late-summer and fall grazing seasons, the diet shifts occurred at stubble heights near 20 cm. When stubble heights approach these levels, managers should carefully monitor the availability and palatibility of preferred herbaceous forages, as these factors will play a significant role in determining diet preferences.

Riparian ecosystems are important to many users and should be managed so that their values can be protected. Detrimental impacts to riparian zones caused by livestock grazing can be minimized by limiting grazing during the summer months and by keeping intensities of use in the moderate range. These recommendations can be accomplished by using rotational grazing systems and by monitoring residual stubble heights.

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APPENDICES

Appendix A: Average biomass values by repition and season. All values are kg/ha.

Season	Rep	Willows	Sedges	Grasses	Forbs	Shrubs	Total
spring	1	76.9	248.0	149.5	5.0	0.0	479.4
spring	2	113.9	382.5	75.5	3.0	20.8	595.7
spring	3	223.5	476.0	229.5	15.5	1368.8	2313.3
early-summer	1	195.5	754.5	642.0	134.5	68.0	1794.5
early-summer	2	92.1	1013.0	564.5	8.5	7.2	1685.3
early-summer	3	592.4	510.3	279.0	107.5	2.4	1491.6
late-summer	1	220.3	708.0	1379.5	286.5	226.4	2820.7
late-summer	2	272.2	1952.0	571.0	138.5	0.0	2933.7
late-summer	3	28.8	1249.5	1391.5	131.0	0.0	2800.8
fall	1	76.6	2050.0	1015.0	39.0	0.0	3180.6
fall	2	375.9	3304.0	281.7	214.5	132.8	4308.9
fall	3	1092.8	1633.0	1186.5	57.0	505.6	4474.9

Appendix B: Analysis of Variance Tables for Diet Data

The MIXED Procedure

Class Level Information

Class	Levels	Values
SEASON	4	1 2 3 4
REP	3	1 2 3
UTIL	4	1 2 3 4
STEER	5	1 2 3 4 5

REML Estimation Iteration History

Iteration	Evaluations	Objective	Criterion
0	1	-185.8694775	
1	4	-201.1548922	.
2	1	-201.5231959	0.00051245
3	1	-201.5808934	0.00002272
4	1	-201.5832600	0.00000006
5	1	-201.5832665	0.00000000

Convergence criteria met.

Covariance Parameter Estimates (REML)

Cov Parm	Ratio	Estimate	Std Error	Z	Pr>|Z|
STEER	0.00663005	0.00058210	0.00646560	0.09	0.9283
REP	0.00000000	0.00000000	.	.	.
SEASON*STEER	0.17260960	0.01515464	0.01062571	1.43	0.1538
UTIL*STEER	-0.00000000	-0.00000000	.	.	.
REP*STEER	0.00000000	0.00000000	.	.	.
SEASON*REP	0.16041807	0.01408426	0.01105718	1.27	0.2027
REP*UTIL	0.22702080	0.01993179	0.01919912	1.04	0.2992
Residual	1.00000000	0.08779720	0.00997492	8.80	0.0001

Model Fitting Information for CAREX

Description	Value
Observations	209.0000
Variance Estimate	0.0878
Standard Deviation Estimate	0.2963
REML Log Likelihood	-76.5635
Akaike's Information Criterion	-84.5635
Schwarz's Bayesian Criterion	-97.6143
-2 REML Log Likelihood	153.1270

Tests of Fixed Effects

Source	NDF	DDF	Type III F	Pr > F
SEASON	3	10.9	0.94	0.4551
UTIL	3	3.85	4.12	0.1065
SEASON*UTIL	9	148	2.23	0.0232

The MIXED Procedure

Class Level Information

Class	Levels	Values
SEASON	4	1 2 3 4
REP	3	1 2 3
UTIL	4	1 2 3 4
STEER	5	1 2 3 4 5

REML Estimation Iteration History

Iteration	Evaluations	Objective	Criterion
0	1	-207.2389721	
1	4	-227.5918622	0.00038650
2	1	-227.6339942	0.00000524
3	1	-227.6345961	0.00000000

Convergence criteria met.

Covariance Parameter Estimates (REML)

Cov Parm	Ratio	Estimate	Std Error	Z	Pr>|Z|
STEER	-0.00000000	-0.00000000		.	.
REP	0.00000000	0.00000000		.	.
SEASON*STEER	0.23233316	0.01816887	0.00933269	1.95	0.0516
UTIL*STEER	0.00000000	0.00000000		.	.
REP*STEER	0.03529689	0.00276028	0.00405550	0.68	0.4961
SEASON*REP	-0.00000000	-0.00000000		.	.
REP*UTIL	0.12841201	0.01004205	0.00862536	1.16	0.2443
Residual	1.00000000	0.07820179	0.00873374	8.95	0.0001

Model Fitting Information for WILLOW

Description	Value
Observations	209.0000
Variance Estimate	0.0782
Standard Deviation Estimate	0.2796
REML Log Likelihood	-63.5378
Akaike's Information Criterion	-71.5378
Schwarz's Bayesian Criterion	-84.5886
-2 REML Log Likelihood	127.0757

Tests of Fixed Effects

Source	NDF	DDF	Type III F	Pr > F
SEASON	3	16.7	1.53	0.2429
UTIL	3	6.18	9.57	0.0098
SEASON*UTIL	9	167	0.90	0.5305

The MIXED Procedure

Class Level Information

Class	Levels	Values
SEASON	4	1 2 3 4
REP	3	1 2 3
UTIL	4	1 2 3 4
STEER	5	1 2 3 4 5

REML Estimation Iteration History

Iteration	Evaluations	Objective	Criterion
0	1	-351.9878598	
1	3	-368.6127516	0.00223827
2	2	-368.8832394	0.00006826
3	1	-368.8965225	0.00000053
4	1	-368.8966217	0.00000000

Convergence criteria met.

Covariance Parameter Estimates (REML)

Cov Parm	Ratio	Estimate	Std Error	Z	Pr>|Z|
STEER	0.01341476	0.00055149	0.00110372	0.50	0.6173
REP	-0.00000000	-0.00000000		.	.
SEASON*STEER	-0.00000000	-0.00000000		.	.
UTIL*STEER	-0.00000000	-0.00000000		.	.
REP*STEER	-0.00000000	-0.00000000		.	.
SEASON*REP	0.25757779	0.01058919	0.00673678	1.57	0.1160
REP*UTIL	-0.00000000	-0.00000000		.	.
Residual	1.00000000	0.04111065	0.00431412	9.53	0.0001

Model Fitting Information for GRASS/RUSH

Description	Value
Observations	209.0000
Variance Estimate	0.0411
Standard Deviation Estimate	0.2028
REML Log Likelihood	7.0932
Akaike's Information Criterion	-0.9068
Schwarz's Bayesian Criterion	-13.9576
-2 REML Log Likelihood	-14.1863

Tests of Fixed Effects

Source	NDF	DDF	Type III F	Pr>F
SEASON	3	7.71	2.48	0.1378
UTIL	3	182	3.73	0.0124
SEASON*UTIL	9	180	1.02	0.4254

The MIXED Procedure

Class Level Information

Class	Levels	Values
SEASON	4	1 2 3 4
REP	3	1 2 3
UTIL	4	1 2 3 4
STEER	5	1 2 3 4 5

REML Estimation Iteration History

Iteration	Evaluations	Objective	Criterion
0	1	-452.2750784	
1	4	-468.3569886	0.02429857
2	3	-469.2409869	0.00055223
3	2	-469.3772501	0.00005119
4	1	-469.3900870	0.00000070
5	1	-469.3902542	0.00000000

Convergence criteria met.

Covariance Parameter Estimates (REML)

Cov Parm	Ratio	Estimate	Std Error	Z	Pr > |Z|
STEER	0.15657881	0.00379816	0.00325236	1.17	0.2429
REP	0.04983048	0.00120875	0.00221213	0.55	0.5848
SEASON*STEER	-0.00000000	-0.00000000		.	.
UTIL*STEER	0.00000000	0.00000000		.	.
REP*STEER	-0.00000000	-0.00000000		.	.
SEASON*REP	0.06828692	0.00165645	0.00189441	0.87	0.3819
REP*UTIL	-0.00000000	-0.00000000		.	.
Residual	1.00000000	0.02425720	0.00254341	9.54	0.0001

Model Fitting Information for FORB

Description	Value
Observations	209.0000
Variance Estimate	0.0243
Standard Deviation Estimate	0.1557
REML Log Likelihood	57.3400
Akaike's Information Criterion	49.3400
Schwarz's Bayesian Criterion	36.2892
-2 REML Log Likelihood	-114.680

Tests of Fixed Effects

Source	NDF	DDF	Type III F	Pr>F
SEASON	3	5.66	5.58	0.0393
UTIL	3	162	1.70	0.1701
SEASON*UTIL	9	152	1.45	0.1735

Appendix C: Steer diet data (% of diet). Values shown are nontransformed data.

Seas	Rep	Util	Steer	Sedge	Willow	Grass/Rush	Forb
1	1	1	1	92.49	2.13	5.38	0
1	1	1	2	84.81	0	14.23	0.47
1	1	1	3	14.09	0	85.91	0
1	1	1	5	94.56	0	4.9	0.54
1	1	3	1	65.81	0	31.78	2.41
1	1	3	2	79.54	0	5.16	0
1	1	3	3	31.86	12.94	3.92	0
1	1	3	5	35	13.67	45.03	0
1	1	3	1	73.23	0	24.79	0.65
1	1	3	2	0	0	1.12	0
1	1	3	3	62.94	5.87	21.11	2.54
1	1	3	5	76.57	5.77	14.59	0.68
1	1	3	1	86.01	0	13.35	0
1	1	3	2	6.49	0	22.8	0
1	1	3	3	94.41	0	5.59	0
1	1	3	5	84.64	0	14.41	0
1	2	1	1	90.13	0	9.87	0
1	2	1	3	86.35	0	13.65	0
1	2	1	4	91.62	0	8.38	0
1	2	1	5	93.74	0	6.26	0
1	2	2	1	95.74	0	4.26	0
1	2	2	3	49.46	6.05	44.49	0
1	2	2	4	77.76	0	22.24	0
1	2	2	5	97.46	0	2.54	0
1	2	3	1	67.97	16.94	15.09	0
1	2	3	3	21.11	45.34	32.81	0.74
1	2	3	4	72.36	10.99	16.65	0
1	2	3	5	58.57	1.71	39.72	0
1	3	1	1	91.14	1.47	6.69	0.7
1	3	1	3	98.02	0.71	1.27	0
1	3	1	4	100	0	0	0
1	3	1	5	90.27	0.51	8.71	0.51
1	3	2	1	84.97	11.48	3.55	0
1	3	2	3	65.8	23.28	10.92	0
1	3	2	4	65.36	1.09	33.55	0
1	3	2	5	36.66	3.43	58.76	0
1	3	4	1	74.07	22.6	3.33	0
1	3	4	3	22.17	66.38	10.97	0
1	3	4	4	94.98	1.1	3.37	0
1	3	4	5	73.67	1.37	24.48	0
1	3	4	1	75.92	22.08	2	0
1	3	4	3	33.38	62	4.62	0
1	3	4	4	100	0	0	0
1	3	4	5	73.26	17.64	4.49	0
2	1	1	1	96.16	0	3.84	0
2	1	1	2	94.06	0.54	1.62	3.24
2	1	1	3	68.95	2.05	22.66	5.76
2	1	1	4	92.93	0	1.76	5.31
2	1	1	5	95.49	0	3.29	1.22
2	1	2	1	5.81	10.26	81.49	0.72
2	1	2	3	72.57	3.51	10.53	8.18
2	1	2	4	80.52	15.34	4.14	0
2	1	2	5	54.58	26.87	16.21	2.34
2	1	2	1	38.46	4.06	41	13.82

Seas	Rep	Util	Steer	Sedge	Willow	Grass/Rush	Forb
2	1	2	3	78.95	1.66	17.14	0.69
2	1	2	4	41.34	13.87	38.37	5.25
2	1	2	5	38.85	1.48	55.73	0
2	1	3	1	76.21	0.68	23.11	0
2	1	3	3	9.94	84.43	5.63	0
2	1	3	4	22.9	17.23	48.76	8.82
2	1	3	5	48.69	0	41.96	9.35
2	2	1	1	36.56	0	63.44	0
2	2	1	3	84.65	0.65	14.7	0
2	2	1	4	60.8	0	38.32	0.88
2	2	1	5	47.73	0.73	50.72	0.82
2	2	3	1	33.41	54.63	11.96	0
2	2	3	3	19.83	0	80.17	0
2	2	3	4	33.98	58.44	7.58	0
2	2	3	5	46.94	0	51.99	1.07
2	2	3	1	22.51	49.05	28.44	0
2	2	3	3	7.47	56.64	35.89	0
2	2	3	4	26.64	53.66	19.7	0
2	2	3	5	26.17	2.14	71.69	0
2	2	4	1	33.53	37.81	28.66	0
2	2	4	3	68.82	12.28	17.93	0.97
2	2	4	4	53.07	28.28	18.65	0
2	2	4	5	77.67	0	22.33	0
2	3	1	1	87.65	12.35	0	0
2	3	1	3	93.25	5.4	0.54	0.81
2	3	1	4	92.49	2.14	4.32	1.05
2	3	1	5	88.33	0	11.67	0
2	3	4	1	26.63	71.62	1.75	0
2	3	4	3	65.14	2.48	31.23	1.15
2	3	4	4	8.67	88.13	2.72	0.48
2	3	4	5	88.55	2.13	8.77	0.55
2	3	4	1	14.73	83.26	2.01	0
2	3	4	3	77.49	9.89	12.62	0
2	3	4	4	2.51	89.25	8.24	0
2	3	4	5	26.25	44.32	28.35	1.08
3	1	1	1	97.28	0	2.19	0.53
3	1	1	2	3.03	7.31	22.46	67.2
3	1	1	3	76.74	0	16.8	4.66
3	1	1	4	10	0	31.67	53.01
3	1	1	5	0	0	30.4	67.8
3	1	2	1	42.5	0	44.99	12.51
3	1	2	2	98.88	0	1.12	0
3	1	2	3	18.92	0	80.2	0.88
3	1	2	4	92.43	0	7.57	0
3	1	2	5	62.83	1.13	34.91	1.13
3	1	2	1	45.82	32.29	19.61	2.28
3	1	2	2	5.73	0	17.3	76.97
3	1	2	3	46.5	0	53.5	0
3	1	2	4	62.85	0.99	17.81	17.55
3	1	2	5	1.83	97.46	0.71	0
3	1	3	1	39.5	58.23	2.27	0
3	1	3	2	16.66	9.05	41.47	32.82
3	1	3	3	88.18	0	10.07	1.75
3	1	3	4	75.06	1.55	8.49	14.9
3	1	3	5	92.1	3	4.37	0.53
3	2	1	1	99.44	0	0.56	0
3	2	1	2	76.38	0.57	2.74	18.09

Seas	Rep	Util	Steer	Sedge	Willow	Grass/Rush	Forb
3	2	1	3	94.55	0	3.26	2.19
3	2	1	4	93.94	0	1.22	4.84
3	2	1	5	97.22	0	1.11	1.67
3	2	2	1	90.97	0.53	1.63	6.87
3	2	2	2	66.7	0	33.3	0
3	2	2	3	87.63	0	10.84	1.53
3	2	2	4	88.48	0.52	7.32	3.68
3	2	2	5	97.76	0.55	0	1.69
3	2	3	1	50.47	34.3	11.06	4.17
3	2	3	2	34.85	61.05	0	4.1
3	2	3	3	88.07	0	11.93	0
3	2	3	4	59.24	35.12	4.41	1.23
3	2	3	5	84.39	5.02	8.98	1.61
3	2	4	1	61.65	6.74	28.45	3.16
3	2	4	2	2.83	97.17	0	0
3	2	4	3	85.56	0.7	11.18	0
3	2	4	4	29.73	68.1	0	2.17
3	2	4	5	53.98	6.15	22.92	0
3	3	1	1	55.6	1.62	12.11	30.67
3	3	1	2	41.84	26.52	14.8	16.84
3	3	1	3	94.33	0.53	4.61	0.53
3	3	1	4	87.73	0.79	2.54	8.03
3	3	1	5	74.15	0	25.85	0
3	3	2	1	77.28	0	20.89	1.83
3	3	2	2	85.49	3.15	9.48	1.88
3	3	2	3	92.61	0	5.1	2.29
3	3	2	4	54.37	7.21	37.21	1.21
3	3	2	5	76.41	13.18	4.54	5.87
3	3	3	1	37.13	6.37	56.5	0
3	3	3	2	26.54	70.26	1.58	1.62
3	3	3	3	82.22	1.16	12.5	4.12
3	3	3	4	41.87	33.14	16.05	8.94
3	3	3	5	89.4	1.62	7.36	1.62
3	3	4	1	49.35	35.01	12.46	3.18
3	3	4	2	5.32	69.57	4.2	20.91
3	3	4	3	10.79	62.96	26.25	0
3	3	4	4	17.65	70.25	12.1	0
3	3	4	5	69.39	8.58	15.97	2.06
4	2	1	1	82.67	6.18	10.68	0.47
4	2	1	2	57.88	0	6.54	32.91
4	2	1	3	74.01	13.86	12.13	0
4	2	1	4	64.43	2.57	32.42	0.58
4	2	1	5	85.29	0	14.2	0.51
4	2	2	1	32.71	61.22	6.07	0
4	2	2	2	29.79	62.77	7.44	0
4	2	2	3	64.47	0	33.19	2.34
4	2	2	4	74.57	2.85	18.88	3.7
4	2	2	5	88.13	0.65	11.22	0
4	2	3	1	20.19	76.67	3.14	0
4	2	3	2	87.9	4.8	5.13	2.17
4	2	3	3	50.4	40.32	9.28	0
4	2	3	4	72.8	12.14	10.59	4.47
4	2	3	5	74.45	0.57	23.23	1.75
4	2	4	1	5.15	94.85	0	0
4	2	4	2	63.86	11.62	18.51	6.01
4	2	4	3	75.63	14.2	10.17	0
4	2	4	4	83.26	1.68	11.83	3.23

Seas	Rep	Util	Steer	Sedge	Willow	Grass/Rush	Forb
4	2	4	5	80.33	11.08	7.81	0
4	1	1	1	95.58	1.1	3.32	0
4	1	1	2	96.17	1.66	0	1.65
4	1	1	3	100	0	0	0
4	1	1	4	98.88	0	1.12	0
4	1	1	5	98.02	0	1.27	0.71
4	1	2	1	17.91	81.16	0.93	0
4	1	2	2	79.29	19.35	0.93	0.43
4	1	2	3	91.32	5.31	3.37	0
4	1	2	4	90.49	0	5.45	4.06
4	1	2	5	89.26	4.84	3.37	2.53
4	1	3	1	45.54	53.93	0	0
4	1	3	2	79.9	4.71	15.39	0
4	1	3	3	100	0	0	0
4	1	3	4	99.44	0.56	0	0
4	1	3	5	99.44	0	0	0.56
4	1	4	1	3.41	96.59	0	0
4	1	4	2	2.93	7.39	2.41	86.77
4	1	4	3	2.63	81.21	0	0
4	1	4	4	32.42	65.16	2.42	0
4	1	4	5	16.51	77.57	5.92	0
4	3	1	1	75.09	2.61	18.29	1.28
4	3	1	2	72.59	17.6	9.81	0
4	3	1	3	92.9	2.14	4.96	0
4	3	1	4	91.95	1.6	5.37	1.08
4	3	1	5	92.67	6.09	1.24	0
4	3	3	1	91.06	2.07	6.87	0
4	3	3	2	75.99	18.7	5.31	0
4	3	3	3	54.94	17.3	27.01	0
4	3	3	4	96.59	3.41	0	0
4	3	3	5	72.24	27.16	0.6	0
4	3	3	1	56.27	42.7	1.03	0
4	3	3	2	61.64	35.83	2.53	0
4	3	3	3	97.72	2.28	0	0
4	3	3	4	88.38	10.07	1.55	0
4	3	3	5	1.11	98.35	0.54	0
4	3	4	1	20.73	75.24	3.58	0
4	3	4	2	91.99	4.43	3.04	0.54
4	3	4	3	22.76	70.58	6.66	0
4	3	4	4	92.67	6.09	1.24	0
4	3	4	5	15.64	77.41	6.95	0